

Nelson Biology VCE Units 1 & 2

Answers to Chapter Questions

Chapter 4

Review questions

- 1 *Paramecium* and diatoms belong to the kingdom Protista, and the main requirement for inclusion is being single celled. However, the structure of the two organisms in question is varied – one is able to make its own organic food (diatom) whereas the other must collect organic matter from its environment. In order to achieve this each has within their cell specialised structures that allow this to occur.
- 2 Single-celled organisms collect their requirements directly from their surroundings and this is best achieved in an aquatic environment where materials, organic and inorganic, are either dissolved in the water or easily transported towards the cells.
- 3 ‘Plant-like’ protists are able to manufacture their own organic materials from inorganic substances. In order to carry out photosynthesis successfully they must possess chloroplasts – organelles that are able to absorb the necessary wavelengths of light that are converted to chemical energy.
- 4 In *Volvox*, though the cells that form the colony are joined, each cell is in direct contact with their environment and each cell is therefore able to receive all its requirements directly and also eliminate wastes.
- 5 A smaller single-celled organism has more of its volume in direct contact with the environment; therefore its surface area to volume ratio is larger. A larger single-celled organism will have a greater volume with the same surface area as a smaller cell; thus it will possess a smaller surface area to volume ratio.
- 6 Carbon dioxide moves into the inside of a cell via diffusion. This is a process that requires no energy input. As carbon dioxide is a small molecule, its passage into the cell is not impeded by the membrane. Therefore, the movement of the carbon dioxide relies on the difference in concentration on either of the membrane – a concentration gradient. When the concentration of CO₂ is lower inside the cell than outside the cell, then CO₂ will move into the cell via diffusion.
- 7 The essential requirements of a large plant include carbon dioxide, water, light, oxygen and minerals.
- 8 The meristematic tissue is the only place in the plant where cells divide – where mitosis occurs. It is found at the apex of roots and shoots and also in a ring in the stem and branches of plants.
- 9 Sucrose moves through a plant via the vascular tissues and in particular the phloem. Sucrose is formed in the mesophyll layer of the leaf and then moves from these cells into the phloem via a concentration gradient. The concentration gradient is maintained because as sucrose enters the phloem tube cells, it is moved away to other parts of the plant, thus ensuring that sucrose will move out of the leaf cells.

Xylem vessels	Phloem vessels
Thick-walled cells, joined end to end	Thin-walled cells, joined end to end
Cells are dead and are just a thoroughfare through which water moves.	Cells are alive with cell organelles that control functions with the aid of companion cells.
Water moves in one direction from roots up the plant.	Sucrose and other plant products move in both directions around the plant.
The wood of a plant is composed of xylem vessels and therefore is the main support structure of plants.	The phloem vessels are living cells arranged end to end that allow plant products to move through them.

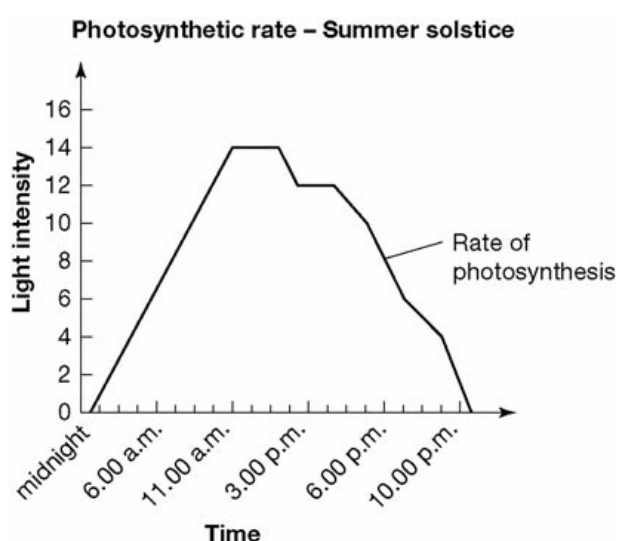
- 11** Dead cells such as xylem vessels provide an uninterrupted pathway through which water flows through a plant. They are also dead strengthened cells that support the plant, particularly trees, and allow leaves to receive the best exposure to necessary sunlight.
- 12** The ground tissue of a plant has specialised functions. If a scientist found ground tissue in the shells of nuts she might conclude that the shells have a support function in the plant, in particular the seeds encased in the nut.
- 13** The main function of roots and stems in plants is to provide an uninterrupted pathway through which water travels up the plant. Both structures also provide support for the plant – the roots anchor the plant and the stem and ensure that it is upright and that leaves receive maximum exposure to sunlight. The roots also, however, are the site of absorption of water into the plant. The stem is unable to provide this function.
- 14** The forces that enable water to move through the xylem vessel and reach the top of the tallest tree are adhesion (the attraction that exists between water molecules and the molecules of the xylem vessel) and cohesion (the attraction that exists between individual water molecules).
- 15** The features of the xylem vessel that make it an effective water transporter include:
- lignified walls that prevent the collapse of the vessel as water is ‘sucked’ up the plant via the transpiration stream
 - the narrowness of the vessels that allow the forces of adhesion and cohesion to work to their best advantage, and
 - the pits in the sides of the walls in some plants that aid the adhesion forces.
- 16** The energy for transpiration comes from the sunlight, which works to evaporate water from the leaves of the plant.
- 17** The main function of the leaf is to allow the maximum levels of photosynthesis to occur. Therefore it captures the sunlight via the chloroplasts in its cells, is the focal point for the passage of water and allows carbon dioxide to enter via the stomata.

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- The epidermis comprises the upper and lower layers of transparent cells in the leaf that allow sunlight to pass through and produce the waxy cuticle. There are also stomata embedded in the layers.
 - The palisade mesophyll is the layer with the cells that are packed with chloroplasts that are best able to harness the energy of the Sun.
 - Stomata are the main gas exchange cells that allow the passage of carbon dioxide into the leaf.
 - Spongy mesophyll are cells with fewer chloroplasts; however, they occur immediately behind the stomata in the lower side of the leaf and allow the gas to diffuse freely within the spaces that occur between the cells.
 - Guard cells make up the stomata and control the opening and closing of the stoma or pore of the stomata. When they take in water they swell and open; when they lose water they become flaccid and close the pore.
- 19 Substances that enter leaves and that are used for photosynthesis include carbon dioxide, water and sunlight (though sunlight is not strictly a substance, but an energy form).
- 20 If petroleum jelly were placed on a plant's leaves, the stomata would be clogged. The rate of transpiration would drop as water would not be able to evaporate out of the leaf, and similarly carbon dioxide would not be able to enter, thus lowering the photosynthetic rate also.
- 21 The factors that would need to be controlled in order to test the predictions include maintaining the levels of water supplied to a plant and ensuring that the plants used were of similar size and contained the same number of leaves. Students should be able to design an experiment and then look at what factors would need to be controlled.
- 22 Mineral ions in a plant go towards the construction and provision of various organelles and other plant structures; for example, ions are required in the production of chloroplasts and chlorophyll.
- 23 Carnivorous plants often lack nitrogen, and collecting and digesting insects provides them with the essential nitrogen required in the production of proteins and nucleic acids.
- 24 The energy for translocation comes originally from the Sun. Photosynthesis converts light energy into chemical energy in the form of sucrose. The sucrose is then broken down to release energy to allow translocation and other functions in the plant to occur.
- 25 The phloem is an ideal transport system for nutrients as it allows the movement of nutrients throughout the plant in both directions. The nutrients are dissolved in the cytoplasm of the cells of the phloem and it moves through the sieve cells via the openings at the ends of the each of the cells.
- 26 Deciduous plants are able to move any waste products to the dying leaves before they drop from the plant. In this way wastes and toxic substances are removed from the functioning organism, allowing it to function at its optimum level.

Apply understandings

- 1 *Volvox* increases its surface area to volume ratio, thus allowing the relatively easy exchange of materials between it and its environment. This is best facilitated by a layer of many cells rather than one large single cell.

- 2 a A plant would be able to supply its own gaseous requirements when the rate of photosynthesis is equal to the rate of cellular respiration. In this way the amount of oxygen produced in photosynthesis would fuel the process of cellular respiration, and the amount of carbon dioxide produced in cellular respiration would drive photosynthesis.
- b The plant would need to take in carbon dioxide and oxygen from the outside when it was growing, as growth requires the use of the products of photosynthesis.
- c A plant kept in the dark will lose weight. The products of photosynthesis would be used in cellular respiration and if the plant was kept in the dark it would not be able to replace those products.
- 3 A plant grown in dim light will not photosynthesise at its optimum rate and transpiration will also occur at a slower rate as the stomata will not need to be open to allow lots of carbon dioxide to enter. If the plant is watered and this water is not being absorbed (as the transpiration stream is virtually stationary), then the cells in the roots will drown, and thus the rest of the plant will die.
- 4 A suggested student response:



- 5 Carbon dioxide enters the leaf via the stomata; oxygen may leave the leaf via the stomata. Carbon dioxide is required in the process of photosynthesis that occurs in the chloroplasts of the palisade and spongy mesophyll cells. It is also a product of cellular respiration that occurs either in the cytoplasm (anaerobic) or in the mitochondria (aerobic) of cells. Oxygen is produced as a by-product of photosynthesis and is also required in the aerobic respiration process that takes place in the mitochondria of the cells.
- 6 Xylem allows the movement of water from the roots of the plant to the plant tip in an unbroken, narrow column known as the transpiration stream. The Sun shining on the leaves, the opening of the stomata and the evaporation of water from the leaves ensure the stream of water is constantly moving up through the plant. In order for this to occur, the xylem must be narrow, reinforced and located so that it leads to the leaves. The process of water movement through the plant does not require the expenditure of plant energy, therefore it can successfully occur in non-living cells. The phloem, however, transports sucrose and other substances to all parts of the plant; therefore, movement occurs in either direction. In order for this to occur successfully, energy is expended occasionally. Cellular respiration must occur; this requires living cells and, specifically, mitochondria. The phloem is made up of sets of two cells that are joined via the cytoplasm they share. This ensures two things: the movement of substances to locations where they are needed, and the availability of energy when required. The living sieve cells and companion cells ensure that this occurs.

Investigate and inquire

- 1 Students' research should look at the structure of the cell wall in all three organisms. As they belong to three different kingdoms, there will be differences in structural components. However, their functions are similar – they protect the cell contents and provide structure for the cell.
- 2 The main feature used to classify *Euglena* as a plant-like protist is its ability to photosynthesise. This is possible because the cell has chloroplasts. Two other identifying features of *Euglena* are the possession of a cell wall and the storage of food as a complex carbohydrate. Students will need to research and be able to compose a list that defines the genus, rather than an individual species.
- 3 The mobility can be grouped into three categories: movement via a 'false foot' (*Amoeba*), the beating of cilia (*Paramecium*) and the whipping of the flagellum (*Euglena*).
- 4 The absence of vascular tissue limits the size of mosses. The cells of a moss need to be almost in direct contact with their environment to ensure they are able to obtain all their requirements.
- 5 The most probable group would be kingdom Protista (single cell) and possibly with the Euglenoids. The flagella, the transparent cell wall and the presence of chloroplasts would be reasons for this classification.
- 6 When transplanting plants, taking some of the local soil is useful as the soil may contain other features that help them survive in its new location, such as bacteria that assist the plant to obtain nitrogen.
- 7 The students should look for the differences between the two and identify the fact that complex compounds are located in organic fertilisers and minerals are what make up the bulk of inorganic fertilisers.
- 8 Stomata open when the guard cells are filled with water. The water is drawn into the cells via the sodium–potassium ion pump. As concentrations of these two ions alter and they are actively transported either in or out of the guard cells, water follows via osmosis. If ions are pumped into the guard cells, water will also move into the cells and the guard cells will swell and open the stomata.
- 9 Factors that affect the transpiration rate of a plant include:
 - humidity of the air around the leaves. The higher the relative humidity of the air surrounding the leaves, the lower the transpiration rate. This is also affected by whether the weather is windy or still. When it is windy, evaporated water will be moved away from the leaves, thus maintaining the gradient of water molecules around the leaf and ensuring that more water will evaporate.
 - the temperature of the ambient air and the availability of sunlight – both will allow the stomata to open, thus allowing the evaporation of water.